NOTICE.

The SESSION of the ROYAL SCHOOL OF MINES and of SCIENCE applied to the ARTS commences early in October in each year, during which the following Courses of Lectures are delivered:

Chemistry, with special reference to its applications in the Arts and Manufactures - - -	E. Frankland, F.R.S.
General Natural History - -	T. H. Huxley, LL.D., F.R.S.
Physics - - - - -	F. Guthrie, F.R.S.
Applied Mechanics - - -	T. M. Goodeve, M.A.
Metallurgy - - - -	John Percy, M.D., F.R.S.
Geology - - - - - -	A. C. Ramsay, LL.D., F.R.S.
Mining and Mineralogy - -	Warington W. Smyth, M.A., F.R.S.
Mechanical Drawing - - -	J. H. Edgar, M.A.

The Chemical Laboratory, under the direction of Dr. Frankland, and the Metallurgical Laboratory, under the direction of Dr. Percy, are open for the instruction of Students.

A Prospectus and Information may be obtained on application to

TRENHAM REEKS, *Registrar.*

Jermyn Street, London, S.W.

90 N.E.

MEMOIRS OF THE GEOLOGICAL SURVEY

OF

ENGLAND AND WALES.

EXPLANATION OF QUARTER-SHEET 90 N.E. OF THE ONE-INCH GEOLOGICAL SURVEY MAP OF ENGLAND,

ILLUSTRATING

THE GEOLOGY

OF

THE COUNTRY AROUND SOUTHPORT, LYTHAM, AND SOUTH SHORE.

BY

C. E. DE RANCE, F.G.S.

PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY.

LONDON:
PRINTED FOR HER MAJESTY'S STATIONERY OFFICE.
PUBLISHED BY
LONGMANS, GREEN, & Co.
AND BY
EDWARD STANFORD, 6, CHARING CROSS, S.W.

1872.

[*Price Sixpence.*]

Pierce found

CONTENTS.

GEOLOGY

OF

THE COUNTRY AROUND SOUTHPORT, LYTHAM, AND SOUTH SHORE.

THE area comprised within this quarter-sheet, is divided naturally into two portions, by the estuary of the Ribble, which between Lytham and Southport is six miles across.

The tract lying south of the river is extremely flat and low, and is a continuation of that peat-covered plain, commencing at Little Crosby and Sefton, a little north of Liverpool, which is described in the explanation of the Geological Survey Map 90 S.E., as extending northwards beyond that sheet, and as consisting of an area "of formerly obstructed "and present artificial drainage." The water falling upon it is raised by an engine at Crossens, placed at the head of the sluice draining Martin Mere, the greater part of which old lake lies in Quarter-sheet 89 N.W., and will be described in the Memoir on that district.

West of the river Douglas (in the latter quarter-sheet), a hill of Boulder Clay occurs, running from Sollom, south of Tarleton, to Hesketh Bank, on the south bank of the Ribble, which somewhat abruptly terminates its northerly extension. Looking across the river to Freckleton Point, a cliff of Boulder Clay, between 30 and 40 feet high, is seen, running west for more than two miles in the direction of Lytham to Bank House. From this low cliff a tract of Boulder Clay extends by Freckleton, Warton, Kirkham, Wrea Green, in 89 N.W.; and Carr Side, Moss Side, Westby, Little Plumpton, in 90 N.E., northwards in the country beyond the northern margin of these two quarter-sheets. The western edge invariably forms an escarpment, overlooking the peat-plain beneath, of which it forms the eastern and landward boundary. Before the river had cut down to its present level, and before the southern edge of this tract had been denuded into the Freckleton cliffs, this escarpment must have been connected almost continuously with that forming the western edge of the tract south of the river, running from Hesketh Bank to Sollom, and the peat-covered plain lying at its foot was once continuous with that occupying a similar position in the country north of the Ribble, and running from Carr Side to South Shore beyond the margin of the map. This is practically proved by the fact of the occurrence of peat under the sea-sand, below high-water mark, and in some instances below low-water mark, at a great number of spots along the coast on both sides of the Ribble. And there can be little doubt that the entire estuarine bed of the Ribble rests upon peat, which once covered the whole of the West Lancashire lowland-plain, from Seaforth and Crosby on the south, to South Shore and Lytham on the north.

Resting on the surface of the peat, and forming the seaward margin of the plain, is a thick deposit of blown sand, both in the tract to the north of the Ribble and in that to the south, varying from a mile and a quarter to two miles in width.

The district comprised in the present quarter-sheet may therefore be divided into three geological areas: an upland plain of Boulder Clay in the north-east corner, a lowland plain covered with peat-moss and alluvium, and a range of blown sand hills; the two latter being cut through by the river Ribble.

Geological Formations.—The following strata are represented upon the present map:—

RECENT	Blown Sand. Alluvium.
TRIAS, or NEW RED SANDSTONE.	Keuper Marls.

TRIAS.

The Keuper Marls alone represent the Trias, and indeed all the deposits older than the Glacial Drift, in the present quarter-sheet. They have been bored into at Lytham, Warton, and Kirkham, north of the River Ribble, without reaching the Lower Keuper Sandstone. It is doubtful whether it was reached in a well made at Scarisbrick Park, and described by Mr. Binney, F.R.S., for after passing through 254 feet of various coloured marls, beds of "List," Shale, Limestone, Grit, and Chert, were found of the aggregate thickness of 40 feet, as described in detail in the Appendix.

At the seaward edge of the great peat-covered plain, the Marls of the Keuper have been bored into to a depth of 186 yards, at the Palace Hotel, Birkdale Park, Southport, in a futile attempt to procure water. The following is an abstract of the beds passed through in this boring, a detailed section of which is given at the end of this explanation:—

1. Sand, blown and sedimentary	78 feet	0 in.
2. Peat, and Sphærium (Cyclas) clay	1 „	6 „
3. Greyish-blue, and yellow, and red marls (Keuper)	479 „	4 „
	558 „	10 „

It is worthy of note that out of the 30 beds enumerated in the detailed section, *eight* bluish-grey and greyish-yellow seams occur in the upper 15, and *eleven* in the lower 15; and that in the whole section there are 100 feet more of greyish-coloured marls than of red, as is shown in the following abstract:—

	ft.	in.	ft.	in.		ft.	in.
Bluish-grey *Marl*	209	0	216	1	Total Grey Marls, &c.	289	0
„ „ *Shaley flag*	7	1					
Greyish-yellow *Marl*	70	0	72	11			
„ „ *Shaley flag*	2	11					
Reddish *Marl*	185	4	190	4	Total Red Marls, &c.	190	4
„ *Shaley flag*	5	0					
	479	4					

A little to the south of the present sheet, the Keuper Marls occur in several sections at Carr Brook, and at Blue Brow, all of which are described in the explanation of Map 90 S.E.* In the Blue Brow section,

* "Geology of the country between Liverpool and Southport, and Explanation of the Geological Survey Map, 90 S.E."

a little knoll covered with Boulder Clay (probably upper) rises from the level of the peat-covered plain, under which occur shales and flags of the Keuper Marls, of a pale cold-grey colour, ripple-marked, and containing pseudomorphous crystals of salt. The ripples strike in a N.N.W. and S.S.E. direction, and the shales become coarser at a depth of 5½ yards, at which horizon a plentiful supply of very hard water was obtained, the beds lying nearly horizontal. Immediately to the north of this section, at Brown Edge, is a small brook or ditch, running at right angles to the Scarisbrick and Southport road, in which occurs a good section of the red and grey marls, the dip being 6° to 8° S.W.

The marls are also well shown in Snig-Pot Brook, near the lane, the beds consisting of grey and red marls, with alternating shales; in one place lying horizontal, but further to the north, towards Sandy Brook, dipping at a low angle to the south-west. In the latter brook the marls are also seen under the alluvium, they contain shaley flagstone, with many pseudomorphs of salt, and are much laminated. To the east they are also seen in the mill-stream, near Bescar Lane, the dip being at one point as high as 25° to the S.S.W.

Red and grey marls also occur under peat, in Black Brook, near New Hall, and from opposite that farm towards Otterstye Bridge, for a distance of 200 yards.

Drift Deposits.

The entire district comprised within this quarter-sheet, with the few exceptions noted above, is deeply covered with glacial and post-glacial drifts, entirely concealing the older rocks beneath, which at Bescar Lane and other places along the eastern edge of the map are but little above the sea level, and in the boring at the Palace Hotel are 65 feet below it. In fact the drifts, not only in the present district, but in the country around Preston (89 N.W.), rest upon a gently inclined surface of Triassic rocks dipping towards the sea, and sinking from 20 feet above the Ordnance datum line at Preston, to 50 feet below it at Southport. This extremely low level is maintained in the country between the latter town and Fleetwood, since, in the futile boring for water made for the War Office at that place, the Keuper Marls could not have been met with at a less distance, from the surface, than 88 feet, as I am informed by Mr. Binney, F.R.S., that the uppermost clay, sunk through in that boring, was certainly Boulder Clay.

The following are the subdivisions into which the drifts were found capable of division, nearly all the names being those used in the "Description of Quarter-Sheet 90 S.E." :—

Post-Tertiary	Recent	Blowing sand. Blown sand.	
		Upper "Cyclas" clay. Sand and Loam.	Alluvium.
		Upper "Scrobicularia" clay	Tidal / Alluvium.
	Pre-historic	Upper Peat.	
		Lower "Cyclas" clay. (Lacustrine.)	
		Lower "Scrobicularia" clay. (Tidal.)	
Newer Pliocene	Post-glacial	Shirdley Hill Sand.	
		Lower Peat.	
	Glacial	Upper Boulder Clay.	
		Middle Sand.	
		Lower Boulder Clay.	

Glacial Drifts.

Lower Boulder Clay.—This clay is well seen near Blackpool, about two miles to the north of the margin of the present sheet. It consists of stiff reddish-brown clay, with bands of marl, and rather sandy loam.

containing a great number of erratic boulders, of which about 66 per cent. are generally scratched and striated. It can be traced south on the beach nearly as far as the South Shore pier, but the clay, on the Lytham side of that pier, appears to belong to the upper sub-division. When the Middle Sand is absent, it is at all times difficult, at low levels, to refer an isolated patch of Boulder Clay to the one division or to the other.

In the Lytham and Southport areas, the Lower Boulder Clay and Middle Sand have experienced much denudation before the deposition of the Upper Boulder Clay, which in the latter area invariably rests directly on the surface of the rock. In the district lying north of the Ribble the Lower Clay appears in some instances to have been denuded before the Middle Sand was deposited, but its sudden thinning out is probably generally due to unequal deposition, which has caused it to rise in abrupt knolls or banks, the hollows between which have been filled up by later glacial deposits.

Middle Sand.—Three patches of this sub-division occur within the quarter-sheet, and both in that portion lying north of the Ribble. The first is the Marl Pit, in Lytham Park, near Bowgrave Bridge, where from 4 to 5 feet of Upper Boulder Clay rest on sandy gravel. The second, is seen in the lane east of the railway, north of Huck Lane and Lytham Dock Station, where it forms the eastern edge of an outlier of Boulder Clay; and the third at Westby, north of the Hall, where 15 feet of it are well seen, capped by 4 feet of Upper Boulder Clay. The sand also nearly reaches the surface at the brickfield near Westby Windmill.

The surface of the Middle Sand and Gravel in this quarter-sheet, as elsewhere in West Lancashire, is extremely undulating, rising in mounds or ridges above the Lower Boulder Clay, which often in the spaces between the mounds is not covered with sand, but supports directly the Upper Clay; a mode of occurrence which adds to the difficulty of distinguishing one clay from the other. The sand is generally current-bedded, the laminations dipping to the S.S.E., proving it to have been probably thrown down by flow-tide currents moving from the N.N.W. Everywhere the pebbles and small boulders which it contains are such as might have been derived from the immediate vicinity; in the Lytham district they were no doubt obtained from the Lower Boulder Clay. A uniformity of level is generally observable in the height of the crests of these sand ridges in a north and south direction, but they are found to rise steadily in advancing from the sea eastwards. It is probable, that they were formed as sand banks in a shallow sea near a gradually subsiding coast, the crest of each marking a level slightly below high-water mark of spring-tides, rising higher and higher on the slopes of the country, as the land sank.

Upper Boulder Clay.—In the district lying north of the Ribble the Boulder Clay forms a considerable portion of the surface, but south of that river it seldom appears, being covered with various post-glacial deposits.

In the brickyard at Fleet Street, Snape Green, near the Scarisbrick road, the following section is seen:—

1.	Sandy vegetable mould, with shells of *Cardium edule* and *C. aculeatum*	1 foot.
2.	Greyish-white sand	1 „
3.	Black sand, charged with vegetable matter, in a peaty condition	1 „
4.	Seam of horizontal water-worn pebbles in dark-blue coloured Boulder Clay	½ „
5.	Red Boulder Clay, with many erratic pebbles and boulders to water-level (at about the 25-feet contour)	4 feet.

Higher up in the pit, the seam No. 4 rises towards the surface, and is cut off by the thin sand above, and about 15 feet of Red Boulder Clay is exposed, with occasional patches of dark chocolate-coloured, dull-greenish, blue-coloured marl; the stones in these portions are generally very small, but scratched. In the red clay many of the boulders are three, four, and even six feet in length, and chiefly consist of Trap and Felspar Porphyry from the Lake District; about 3 per cent. of the boulders consists of granite, most of which appears to have been derived from Criffel.

To the west and south the sandy seam (No. 1) becomes gradually more peaty. In an excavation made in 1869, for laying the water pipes between Scarisbrick and Southport, the following section was observed, between the parish boundary and Brown Edge :—

1.	Dark or black heavy *peat*, with roots of trees - -	1 foot.
2.	Light ash-grey, loose quartzose sand - - -	2½ feet.
3.	Brown and Red Boulder Clay, with erratics - -	4 „
5.	Blue and red marls (Keuper Marls) - - -	2 „

The Boulder Clay [1] in the Scarisbrick district, of a dull brick-red colour, has not the crimson or slightly violet tinge observable in the red marls of the Keuper. The contrast between the two is well shown near Brook Bridge, Wyke Lane, west of Bescar Station, where the clay is seen resting on the marls. In the Fleet Street brick-field there are irregular masses of a peculiar blue-coloured marl in veins or strings in the Boulder Clay. Similar masses occur largely in the Upper Boulder Clay of the Lytham district. This is particularly the case in the Lytham and Blackpool railway cutting, near Lytham parish-church, in the marl-pit east of Moss Hall, where it is intensely hard, and contains a few pebbles, all of which are scratched; and in the marl-pits at Robin's, and at the Fold, Moss Edge Lane. In the Robin's pit, occurs a boulder of porphyry 6 feet by 3½ feet, by 3 feet. The blue marl is also seen in a pit opposite Walker's Hill, east of Milkers Gat Lane.

The boundary of the main mass of Upper Boulder Clay, commencing from the north, begins between the letters "*g*" and "*e*" of Carr Bridge, west of Little Plumpton on the one-inch map; thence by the "*a*" of Lowlands, east towards Westby Hall; then west to Rough Heys, and again east to Corka Barn, towards which runs a depression with peat at the bottom, the Boulder Clay again running westward around Brown Moss and Moss Side Station; south of which it runs east to the margin of the map, entering the next sheet near Carr Side. The largest outlier is that of Lytham Park, where the clay is much concealed by blown sand, but is seen in the pond south of the Hall and in the two ponds to the north, as well as in the marl pits and railway-cutting described above. A small knoll of clay surrounded with alluvium, occurs a little north of the park, around Snape's House, and west of Lower Ballam. Another small knoll occurs, east of the Park, at Mythorp; and from the pond, near Saltcoats Bridge, a knoll is seen extending across the railway from Eastham to Huck Lane, and the Middle Drift Sand. Between this knoll and that of Mythorp, the Boulder Clay rises to the surface, and forms a ridge from Birks to Saltcoats, for the distance of about a mile, with an average width of 200 yards. At the latter place it is cut through by the Lytham and Kirkham Railway, about 20 feet being exposed.

A large knoll of Boulder Clay rises from the peat-plain to a height of 42 feet, at Peel Castle, extending from Higher Ballam to Master Lane,

[1] The Boulder Clay in this map occupies an area of 4⅛ square miles north of the Ribble, and 0¼ to the south. In 90 S.E. it occupies 5⅛ square miles, and 4¼ miles between Crossens and the R. Douglas in 89 N.W.

for more than a mile, in a north-westerly direction, with a width of nearly half a mile. To the north it is separated by a belt of peat from the Boulder Clay knoll around Ripers Heights, which extends into the next quarter-sheet. Three other small knolls or outliers occur on the eastern edge of the tract of blown sand; the one at Robin's Row,[1] the others at Stockdale Lane and east of The Folds, all of which have been already alluded to. The Upper Boulder Clay, no doubt, forms the outer substratum of the peat and Cyclas clay. It is manufactured into bricks at Saltcoats and near Westby Windmill, north of the Ribble, and near Guinea Hall to the south. The calcareous portion is much used for "marling" the land in both districts.

Post-Glacial Deposits.

Shirdley Hill Sand.—There is only a small exposure of this subdivision in the present quarter-sheet. North of the Ribble it does not occur, and even as far south as the district around Crossens the peat rests directly on the Boulder Clay. But it occurs in some force to the east, at Holmes Wood, near Martin Mere, where it masks the cliff of Boulder Clay, which must have formed the sea-margin before the growth of the peat, on the great lowland plain of Western Lancashire, much of the margin of which is described in the explanation of 90 S.E. of the Geological Survey Map. Only a small portion of this old sea-margin occurs in the present sheet; it extends from Sandy Brook to Black Brook, near Otterstye Bridge, north of Snape Green. Around the latter hamlet the Shirdley Hill Sand covers and conceals the Upper Boulder Clay. In cutting a trench there for the reception of the pipes of the Southport Water Company, the sand was found to be six feet in thickness. West of Carr Cross, a little to the east, it thins away to two feet. In Cattail Lane the sand is a beautiful pure white, but a little to the east, towards the brook, it assumes its ordinary yellow tint.

Lower Cyclas *Clay.*—This clay is well seen in the deep sluices and ditches in Halsall Moss, near the Isle of Wight. It consists of a pale-grey freshwater marl, with shells of *Sphærium* (*Cyclas*) *cornea*. It invariably underlies the peat; but to the east the latter overlaps it, and rests on the Shirdley Hill Sand or on the Boulder Clay. The clay probably thins away, in a north-easterly direction, from Birkdale Cop, a little east of the Boundary sluice, crossing the railway a little west of Poolhey Lane, to Wyke Moss; then easterly, by Sniddlepool Cover, off the margin of the map, which it re-enters to the north, a little east of "The Sluice," passing under the alluvium of Crossens. An unsuccessful attempt was made to manufacture this clay into bricks in 1868, a pit being dug in the peat near the Isle of Wight. But in a brickyard near Formby, the same clay is worked, by steam-machinery, into very fair bricks.

Peat.—With the exception of the small tract composed of Shirdley Hill Sand, south of the Ribble, and the Boulder Clay of Westby, Little Plumpton, and Peel, north of the river, the whole of the district under consideration is covered with this deposit, either at the surface or beneath the Blown Sand surrounding the coasts, and the alluvium in the neighbourhood of the brooks and sluices.

At Halsall Moss the peat is from six to nine feet in thickness, east of Blowick ten feet, Wyke Hey eight feet, Trunny Lane, near Crossens, five

[1] In the clay-pit behind Robin's there is a scratched and smoothed boulder of Porphyry, $6 \times 3\frac{1}{2} \times 3$ feet in size. At the Folds occurs another, 4 feet in length, in bluish-coloured clay.

feet, resting on the Cyclas (Sphærium) Clay; it is four feet thick south of Guinea Hall, and five feet at Gravel Lane, resting on Boulder Clay; five feet at Pool Hey Lane, resting on Shirdley Hill Sand; but its average thickness south of the Ribble may be taken, in this district, at 12 feet.

The following Table shows the height of its base where it rests on the Cyclas Clay, above the Ordnance datum-line:—

In Lancashire, 6-inch maps.	75 Old Brook, White Hey	4 feet.
	„ Moss Lane, Church Town	8 „
	83 Birkdale Cop, London Lane	11 „
	„ Crantum New Cut Lane	11 „
	„ New Moss, New Cut	4 „
	„ Headbolt Lane	6 „

At Snig Pot Brook, near Scarisbrick, about seven feet of sandy alluvial loam rest on a very dark, bluish-coloured lacustrine clay, weathering white, and a thin bed of peat resting on the Upper Boulder Clay and the marls of the Keuper. The grey lacustrine, or fluviatile, marl between contains the shell *Sphærium corneium*, and the elytra of two species of beetle. In the bed of peat, with their roots in the Boulder Clay and Keuper marls beneath, occur the remains of large trees, chiefly oaks, the bases of the trunks of which, immediately above the roots, being often from two to three yards in diameter. In some places a thick deposit of hazel (*Corylus avellana*) occurs in the forest-bed, but invariably, at the upper surface of the peat, in some parts of the section, the roots of the trees are entirely in the peat, and do not penetrate so low down as the Boulder Clay. The alluvium lying above the lacustrine clay is a sandy deposit, apparently derived from the Shirdley Hill Sand, patches of which are found overlying the hillocks of Upper Boulder Clay in the neighbourhood.

By the sea-margin at Goose Dub Bank, north of Crossens, the peat disappears under the tidal and salt-marsh clay. A little to the south, by Eccles Place, under three feet of blown sand, is seen three feet of peat, resting on four feet of dark-green sand, containing a great quantity of shells of *Tellina Balthica*, and a few of *Cardium edule*, beneath which sand occurs another bed of peat lying on a grey clay containing shells of *Scrobicularia piperata*. This section, in the presence of the seam of *Tellina Balthica* sand in the peat, and the Lower Scrobicularia clay below it, precisely corresponds to those I have described as occurring in the neighbourhood of Leasowe, in North Cheshire.[1]

About one and a half miles west of Birkdale Palace Hotel, and 800 yards seawards of the base of the sand-dunes, is a bed of laminated stratified clayey sand, black when wet, but assuming a light-grey colour after a few hours exposure to the atmosphere. It contains shells of several species of mollusca, of which I collected the following:—*Turritella communis*, *Fusus contrarius*, *Tellina Balthica*, *Mactra solida*, *Psammobia Ferröensis*, *Donax anatina*.

On the sands, near this point, great quantities of hard peaty shale of great density are washed up by the tide, probably derived from the peat banks at the mouth of the River Alt, described in "the explanation of 90 S.E." The peat occurring in spherical nodules, much resembles a carbonaceous shale of Carboniferous age, and contains a considerable number of leaves and stems of water-plants, as well as leaves of the oak, birch, alder, and hazel. Isolated leaves of the Spanish chestnut are also often washed ashore in a peaty condition; but it is not possible to affirm with certainty that they are derived from the peat, more especially as both sides of the leaves are invariably more or less coated with

[1] Quart. Journ. Geol. Soc., vol. xxvii. p. 656.

Eschara and other Polyzoa, proving them to have been under water for a considerable time. Occasionally fragments of bark and nuts of the hazel occur in the nodules of peat, as well as branches and portions of the trunks of the oak and other trees, many of which have been bored by Pholades, proving the wood and peat to have been *fixed* between tide marks before it was loosened and launched upon the tidal currents, and borne north by the flow tide.

It may be, perhaps, well to mention here, that from Crossens, south to the margin of the map, and southwards in 90 S.E. to Seaforth, the beach consists entirely of sand. No pebbles are ever found except those brought by the agency of floating seaweeds and zoophytes (but chiefly the latter), and consisting chiefly of Silurian and Metamorphic rocks, possibly derived from the Isle of Man, in which locality many of the zoophytes at present flourish, and to the coasts of which some of them are restricted. These pebbles vary from a quarter of an inch to four inches in size, the heaviest that I have seen weighing rather more than three-quarters of a pound.

The bed of marine silt referred to above (locally known by the name of "slutch"), not only crops out at the spot mentioned, and more or less near low-water mark, all along the coast of Ainsdale and Southport, but underlies the sand in a continuous sheet nearer the land. It is occasionally dug in pits, for agricultural purposes, many of which near Southport have had to be filled up, as they caused dangerous quicksands.

The silt, by rough analysis, consists of 75 per cent. clay, 15 per cent. sand, and 10 per cent. shell-sand, or lime.

North of the Ribble, in Lytham Moss, the peat is generally not more than eight feet in thickness. It is bounded to the east and north by slopes of Upper Boulder Clay, which deposit, at Peel, Robin's, Stockydale Lane, and elsewhere, rises from the plain, and forms knolls or outliers overlooking the peat. Near the edge of that around Robin's a bronze celt was found some years ago in the peat. In the hollows between these knolls, and wherever the peat lies lowest, it rests on a freshwater Cyclas Clay of a grey and sometimes yellowish-red colour, and containing a great quantity of the roots of an aquatic plant. The junction of the two deposits is well seen on the sea-coast at South Shore, from the south of Layton Lane to the Royal Hotel, and east of Lytham, where the margin of the map cuts the sea-coast. Here, as in Lytham Moss and in the mosses east of Southport, great numbers of trees occur, with their roots in the sub-soil beneath, and their trunks lying prostrate in the peat. These in Lytham Moss chiefly consist of oaks and alders; they generally lie with their heads to the east, and appear to have been blown down by a western gale at a period when the lower part of their trunks had become rotten through being surrounded by stagnant water, before the growth of the peat.

Alluvium.—A considerable extent of this deposit occurs at Crossens, overlying the peat; it consists of sandy loam, and of a grey clay or warp below, which appears to have been formed partly by tidal action. A similar tidal alluvium occurs at Lytham, running inland for a considerable distance, and there also overlying the peat. It appears to have been formed under similar conditions to the salt-marsh clays, now being thrown down by the united action of the Ribble and the tides in the adjacent estuary of that river. The alluvium at Bescar Lane consists of ordinary sandy loam resting on Boulder Clay.

Blown Sand.—In this district, as in that described in the Explanation of 90 S.E. and in that lying between the mouths of the Mersey and the Dee, the base of the blown sand where it rests on the peat, is a stratified deposit, containing a great number of freshwater shells, particularly of

the species *Bithynia tentaculata*. This Bithynia Sand was well seen during the progress of the Survey in the pit at Birkdale, north-west of the Isle of Wight, where it is of a dark green colour at the base, and contains shells of the following mollusca :—

FRESHWATER.

Sphærium (*Cyclas*) *corneum*, Linn.
„ *lacustre*, Muller.
„ *rivicola*, Leach.
Pisidium amnicum, Müll.
Anodonta cygnæa, Linn.
Paludina vivipara, Linn.
„ *contecta*, Millet.
Valvata piscinalis, Müll.
„ *cristata*, Müll.
Helix aspersa, Müll.
„ *nemoralis*, Linn.
Carychium minimum, Müll.
Clausilia rugosa, Drap.
Cochlicopa lubrica, Müll.
Succinea putris, Linn.
Physa fontinalis, Linn.
„ *hypnorum*, Linn.
Vertigo minutissima ? Hart.
„ *edentula*, Drap.
Planorbis albus, Müll.
„ *vortex*, Linn.
„ *contortus*, Linn.
Limnea stagnalis, Linn.
„ *palustris*, Müll.
„ *peregra*, Müll.
Ancylus fluviatilis, Müll.

MARINE.

Turritella terebra, Linn.
Buccinum undatum, Linn.
Cardium edule, Linn.
„ *echinatum*, Linn.
Tellina Balthica, Linn.

All the marine shells were more or less worn and broken, and had evidently been blown into the fresh-water morass from the sea-shore, which at present is about a mile distant from the spot. In this pit a thin seam of peat occurs above a seam of sand 4 inches in thickness, proving that not only was the surface of the country covered with shallow water, at the period of the first blowing from the sea of sand and fragments of sea-shells, but that those conditions which induced the growth of peat had entirely ceased.

The modern town of Southport, and the older "North"* Meols, are both built on thick deposits of blown sand. As buildings extend in the former town, the sand hills, or dunes, are carted away, and houses built on the sandy flat thus formed. The sand gradually thickens seawards or westwards, from its eastern boundary, shown on the map, as running a little west of Blowick Moss, by Foul Lane, Pitt's House, Moss Lane, Gore Hey, Bank Field, to the sea coast, half a mile west of Crossens. Along this boundary, from the southern margin of the map to the letter "*a*" in Meol's Hall, the blown sand rests on peat. Northwards from this point to the sea-coast it rests on alluvium, chiefly "tidal," which itself is deposited on the peat.

It is somewhat difficult to assign the date at which the sand first commenced to accumulate in this district upon the surface of the peat, but there is reason to believe that it has been blowing here for a longer period than in the country further to the south, (as at Formby (in 90 S.E.),) where it is stated that in 1690, there were no sand hills, while at the present time, there is a tract of blown sand more than 3 miles in width, being probably one of the broadest tracts of blown sand in any part of England or Wales. The sand is said to have first commenced blowing here from a sand-bank, which joined itself to the land in consequence of the silting up of a channel which led to what was then Formby Harbour, but which is now the Altcar Rifle Range of the West Lancashire Volunteer Corps. From this bank the sand was gradually blown over the land, to such

* Only so called since the end of the last century, in contradistinction to "South" port, a conventional and modern name; the old fishing village, which occupied the centre of the site of the present town, being formerly called South Hawes. North Meols, is now generally spoken of as "Churchtown."

an extent that the churchyard was covered up, and the parish church had to be removed inland in 1746; and in 1750 the streets, cultivated gardens, and orchards, on the land-side of the site of the old church, were buried. This former cultivated surface is now invariably met with in making borings, wells, or excavations in this district. It evidently consisted of a burnt and drained surface of peat-moss, and I have twice had an opportunity of seeing sections in which it is clear that the peat had been cut for fuel, in precisely the same manner as it is at present, by the inhabitants of the peat districts of "Christis Crofte" and the "Fylde," for the purpose of affording fuel, and that the space left vacant was subsequently filled in with blown sand.

In 1868 I saw a similar instance at South Shore, near Blackpool, a little north of the margin of 90 N.E. The houses at that place are very near to the sea, and much exposed to its action, the surface of the ground being only a few feet above the level of spring-tide high-water mark, and composed of the loose and yielding Bithynia sand, resting on peat, which is now concealed by an embanked wall. This embankment in 1868 was in process of construction, but had been partly destroyed by the sea during a recent heavy gale, which had also exposed the foundation of an adjacent house, built upon peat, in the midst of which was a broad trench, filled up with blown sand, the remains of old turf-diggings, made before the sand blew, and when the sea-coast stood much further out than at present.

Between Formby and Birkdale, on the confines of the present sheet, many farms have been entirely covered up during the last 80 years, one especially, known as the "Lost Farm," about two miles and a half to the south of Southport, and a quarter of a mile inland. In the year 1824 or 1826, a portion of the building was still standing covered to a depth of 3 or 4 feet with sand, but 20 years later, as now, all trace of the house had disappeared.

At Freshfield, north of Formby, Mr. Fresh commenced reclaiming the sand, and bringing it under cultivation in 1850 with eminent success, and a considerable area in 90 S.E. and 90 N.E., is now producing grain and root-crops. This is particularly the case on the eastern side of the sand tract; but on the western side, where the dunes are highest and most subject to movement, their progress has been much retarded, and in many places almost entirely stopped by the long and matted roots of the "starr grass" or "marrem" *Psamma arenaria* R. and S. (*Ammóphila arundinacea*, Host) the growth of which was protected by an Act of Parliament passed in the reign of Queen Elizabeth.

Rain-water, more or less charged with carbonic acid, acting upon the numerous shells contained in the blown-sand, slowly dissolves and removes them, particle by particle, as bi-carbonate of lime, which upon being re-deposited in a solid form in the sand, renders it sufficiently impermeable to enable the sand in the flats between the sand-hills to hold water, making a series of shallow ponds, locally known as "Slacks," several of which occur between Lytham and South Shore, the largest being known as "Cross Slack." These slacks and wet places during the summer retain sufficient moisture to support a tolerably luxuriant vegetation;* and from the calcareous nature of the soil, many of the plants are of species peculiar to chalk and calcareous districts (as *Chlora perfoliata*, and several species of *Erythræa*).

The sand dunes rising above the plain having generally a steep bluff or cliff-like face toward the prevailing wind, which in this district

* "Notes on the Geology of the country around Liverpool," by C. E. De Rance, F.G.S.—*Nature*, vol. ii. p. 391 (1870).

is about W.N.W., (blowing for nine months in the year), and a long gradual slope in the opposite direction, or to the E.N.E. A section through one of the sand-hills in this direction, is the longest line that can be drawn through one, and forms what may be called the major axis, the steep side being the "major bluff," and the long gradual slope the major slope; a minor bluff, with an angle *less steep* faces the S.W. wind; and a minor slope, with an angle more steep, terminates the minor axis to the N.E. The sand is blown up the bluffs and down the slopes, being partly fresh sand, and partly the waste of the bluff itself, this constant change of parts driving gradually inland, with an almost imperceptible movement.

The fresh sand is brought by the combined influence of winds, tides, and currents from the Mersey and the Dee; it is especially deposited and blown on to the shore during the neap tides in mid-summer, where it forms immense flats of sand between the spring and ordinary high-water marks. Then being exposed to the rays of the sun, and thoroughly dried and loosened, a fresh breeze is enabled to lift and carry it in a cloud of unequal density, of from 5 to 20 feet in height, over the sandy surface of the beach, gathering as it travels to the sand-hills inland, which from being higher than the moving cloud of sand, check its course, and cause its precipitation at the foot of their bluffs.

The height of the moving clouds of sand entirely depends on the velocity of the wind; during gales the sand is raised at least 200 feet from the surface, and is carried considerable distances inland. Thus, at Freshfield, a storm of sand happened to blow at the time when the station was covered with wet paint, the surface of which was so coated with sand, that it formed a good and durable stucco; and at Crossens, a fisherman was able in 20 years to entirely destroy a sand-hill, 40 feet in height, before his cottage, by simply loosening the sand with a rake every time the wind blew with considerable velocity.

The sand-hills on the north bank of the estuary of the Ribble, between Lytham and South Shore, are generally lower than those of Ainsdale and Birkdale; they seldom rise to a greater height than 30 feet above the level of the slacks. Between the Lighthouse and Stoney Gate the sand-hills are seen to rest upon a bed of shingle, forming to a certain extent a raised beach; but it appears rather to imply a slight gain from the sea in that tract, than an actual rise of the land, the pebbles in question probably forming a "storm-beach" when the sea stood further inland than it does at present.

The process of natural embanking is well seen in the interesting shingle-bank, known as the Double Stanner, west of Lytham, which has thrown out its finger-like projections to the eastward a considerable distance, since the date of the Ordnance Survey. Its method of progression will be described in the "Memoir on the Country around Preston, Blackburn, and Burnley."

The broken ground at the east end of Lytham, from the Windmill nearly to the Dock, consists of shingle, sections of which are exposed in the various small pits. In one of these, a thickness of 11 feet of shingle is exposed, towards the bottom of which occurs a bed of fine sand, dipping westward, and resting on a seam of clay four inches thick, the pebbles beneath which clay form the base of the section and are very large; the surface consists of a couple of feet of blown sand. Out of 100 of the large pebbles 30 were Silurian grit and Felspathic rocks, 28 were porphyry, 12 granite, and 4 quartzites. In the sand occurred shells of *Cardium edule*, *Tellina Balthica*, and *Mytilus edulis*.

APPENDIX.

SECTION of BORING for a WELL, at the Palace Hotel, Birkdale Park, Southport.

DESCRIPTION OF BEDS.	Thickness of Beds.	Thickness of Flags.
	Ft. In.	Ft. In.
Sand (Blown and Sedimentary)	78 0	—
Peat and Cyclas Clay	1 6	—
Red Marl (possibly a portion of the upper part may have been Upper Boulder Clay).	45 0	0 6
Grey Marl	12 4	0 4
Grey Flag	0 6	(0 6)
Red Marl	5 0	—
Blue (Grey) Marl	6 0	—
Red Marl	8 0	—
Blue (Grey) Marl	3 0	—
Red Marl	6 5	0 5
Yellowish-grey Marl	8 5	0 5
Blue (Grey) Marl	10 5	0 5
Red Marl	6 6	0 6
Blue (Grey) Marl	10 6	0 6
Red Marl	8 6	0 6
Blue (Grey) Marl	14 8	0 8
Red Marl	18 0	—
Blue (Grey) Marl	21 4	0 4
Yellowish-grey Marl	12 3	0 3
Blue (Grey) Marl	14 5	0 5
Red Marl	21 4	0 4
Blue (Grey) Marl	15 7	0 7
Red Marl	18 6	0 6
Blue (Grey) Marl	21 8	0 8
Yellowish Marl	25 9	0 9
Blue (Grey) Marl	25 10	0 10
Red Marl	26 10	1 0
Blue (Grey) Marl	23 1	1 1
Red Marl	26 3	1 3
Yellowish-grey Marl	26 6	1 6
Blue (Grey) Marl	22 4	0 4
Blue (Grey) Marl	14 5	0 5
Total depth from the surface	558 10	15 0

SECTION of WELL-BORING, made at Scarisbrick Park, Scarisbrick.
(Given by Mr. E. W. Binney, F.R.S., in Mem. Lit. Phil. Soc. Man., 2nd series, Vol. xii. p. 250.)

	Ft.	In.
Soil	3	0
Brown Sand	4	6
Brown Clay	1	7
Variegated Marl	230	8½
White-grit Pebble	0	7½
Variegated Marl	18	0
Blue Loam	4	2
Blue-grit List (Flagstone?)	19	3½
Brown Strong-rock List	1	1
Limestone List, and Limestone Shale	7	4½
Brown Flint Kernel	1	7
Blue-grit List	2	0
Brown open Grit	1	10
Blue shale	6	8½
Brown Flint (Chert?) Pebble	0	4
Blue Shale	0	5
	306	2½

The following shells of Marine Mollusca were found in the sand-hills, between Birkdale and Ainsdale.*

Buccinum undatum, Linn.	r.	*Ostrea edulis*, Linn.	r.
Fusus antiquus, Linn.	r.	*Anomia aculeata*, Müller	r.
Fusus gracilis, Da Costa	v.r.	*Pecten varius*, Linn.	r.
Purpura lapillus, Linn.	v.r.	„ *opercularis*, Linn.	r.
Nassa inerassata, Müller	v.r.	„ *maximus*, Linn.	v.r.
Cypræa Europæa, Mont.	r.	*Mytilus edulis*, Linn.	v.r.
Mangelia gracilis, Mont.	r.	*Nucula nucleus*, Linn.	c.
Natica monilifera, Lamarck	c.	*Cardium edule*, Linn.	v.c.
„ *nitida*, Donovan	r.	„ *echinatum*, Linn.	c.
Aporrhais pes-pelecani, Linn.	v.r.	*Cyprina Islandica*, Linn.	c.
Turritella terebra, Linn.	v.c.	*Venus striatula*, Don.	c.
Scalaria communis, Lamarck	r.	*Artemis lincta*, Pult.	r.
Dentalium entalis, Linn.	r.	„ *exoleta*, Linn.	r.
Tornatella fasciata, Linn.	r.	*Mactra solida*, Linn.	c.
Lucinopsis undata, Penn.	r.	„ *stultorum*, Linn.	v.c.
Lutraria elliptica, Linn.	c.	*Corbula nucleus*, Lam.	r.
Psammobia Ferröensis, Chemn.	c.	*Saxicava rugosa*, Linn.	r.
Syndosmya alba, Wood.	r.	*Thracia convexa*, Wood	r.
Donax anatinus, Lam.	v.c.	„ *phaseolina*, Lam.	v.r.
Solen ensis, Linn.	c.	*Pholas candida*, Linn.	v.c.
„ *siliqua*, Linn.	c.	„ *cristata*, Linn.	c.
Mya truncata, Linn.	c.	*Ceratosolen legumen*, Linn.	v.r.
„ *arenaria*, Linn.	c.		

* The above is a list of the shells I collected in the midst of the sand dunes, more especially where fresh sections were exposed, and generally at a distance of half a mile from the sea coast. Every species in the list may be found on the present beach, associated with many species that are not present on the sand hills; but a great number of the shells, though all of existing species, are never found *living* in the adjacent sea, being probably washed out of a bed of post-glacial marine drift, situated below low-water mark.

LONDON:
Printed by GEORGE E. EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.
[4318.—250.—4/72.]

LIST OF GEOLOGICAL MAPS, SECTIONS, AND PUBLICATIONS OF THE GEOLOGICAL SURVEY OF THE UNITED KINGDOM.

THE Maps are those of the Ordnance Survey, geologically coloured by the Geological Survey of Great Britain and Ireland, under the Superintendence of Sir RODERICK IMPEY MURCHISON, Bart., K.C.B., F.R.S., Director-General. The various Formations are traced and coloured in all their Subdivisions.

ENGLAND AND WALES.

(Scale one-inch to a mile.)

Maps, Nos. 3 to 41, 44, price 8s. 6d. each, with the exceptions of 2, 10, 23, 24, 27, 28, 29, 32, 38, 39, 58, 4s. each.
Sheets divided into four quarters, (1 N.W., N.E., S.W., S.E.), 42, 43, 45, 46, 52, 53, 54, 55, 56, 57, (59 N.E., S.E.), 60, 61, 62, 63, 71, 72, 73, 74, 75, (76 N., S.), (77 N.), 78, 79, 80, 81, 82, 89, 105 (87 N.E., S.E.), (88 N.W., S.W., S.E.), (90 S.E., N.E.), (91 S.W.), (98 S.E.), (109 S.E.) Price 3s. Except (57 N.W.), 76 (N.), (77 N.E.) Price 1s. 6d.

SCOTLAND.

Maps 7, 14, 24, 32, 33, 34, 40, 41, 6s. each. Map 13, 4s.

IRELAND.

Maps 21, 29, 36, 37, 49, 82 to 92, and from 95 to 205, price 3s. each, with the exception of 38, 82, 122, 131, 140, 150, 159, 160, 170, 180, 181, 182, 189, 190, 196, 197, 202, 203, 204, 205, price 1s. 6d. each.

HORIZONTAL SECTIONS,

Illustrative of the Geological Maps.

1 to 84, England, price 5s. each. 1, 2, Scotland, price 5s. each. 1 to 21, Ireland, price 5s. each.

VERTICAL SECTIONS,

Illustrative of Horizontal Sections and Maps.

1 to 40, England, price 3s. 6d. each. 1, Ireland, price 3s. 6d. 1, Scotland, price 3s. 6d,

Memoirs of the Geological Survey and of the Museum of Practical Geology.

REPORT on CORNWALL, DEVON, and WEST SOMERSET. By Sir H. T. DE LA BECHE, F.R.S., &c. 8vo. 14s.
FIGURES and DESCRIPTIONS of the PALÆOZOIC FOSSILS in the above Counties. By PROFESSOR PHILLIPS, F.R.S. 8vo. (*Out of print.*)
THE MEMOIRS of the GEOLOGICAL SURVEY of GREAT BRITAIN, and of the MUSEUM of ECONOMIC GEOLOGY of LONDON. 8vo. Vol. I. 21s.; Vol. II. (in 2 Parts), 42s.
BRITISH ORGANIC REMAINS. Decades I. to XII., with 10 Plates each. MONOGRAPH No. 1. On the Genus Pterygotus. By PROFESSOR HUXLEY, F.R.S., and J. W. SALTER, F.G.S. Royal 4to. 4s. 6d.: or royal 8vo. 2s. 6d. each Decade. MONOGRAPH No. 2. On the Structure of Belemnitidæ. By PROFESSOR HUXLEY, LL.D., &c. 2s. 6d.
RECORDS of the SCHOOL OF MINES and of SCIENCE applied to the ARTS. Vol. I., in four Parts.
CATALOGUE of SPECIMENS in the Museum of Practical Geology, illustrative of the Composition and Manufacture of British Pottery and Porcelain. By Sir HENRY DE LA BECHE, and TRENHAM REEKS, Curator. 8vo. 155 Woodcuts. 2nd Edition, by TRENHAM REEKS and F. W. RUDLER. Price 1s. 6d. in wrapper; 2s. in boards.
A DESCRIPTIVE GUIDE to the MUSEUM of PRACTICAL GEOLOGY, with Notices of the Geological Survey of the United Kingdom, the School of Mines, and the Mining Record Office. By ROBERT HUNT, F.R.S., and F. W. RUDLER. Price 6d. (3rd Edition.)
A DESCRIPTIVE CATALOGUE of the ROCK SPECIMENS in the MUSEUM of PRACTICAL GEOLOGY. By A. C. RAMSAY, F.R.S., H. W. BRISTOW, F.R.S., H. BAUERMAN, and A. GEIKIE, F.G.S. Price 1s. (3rd Edit.)
On the TERTIARY FLUVIO-MARINE FORMATION of the ISLE of WIGHT. By EDWARD FORBES, F.R.S. Illustrated with a Map and Plates of Fossils, Sections, &c. Price 5s.
On the GEOLOGY of the COUNTRY around CHELTENHAM. Illustrating Sheet 44. By E. HULL, A.B. Price 2s. 6d.
On the GEOLOGY of PARTS of WILTSHIRE and GLOUCESTERSHIRE (Sheet 34). By A. C. RAMSAY, F.R.S., F.G.S., W. T. AVELINE, F.G.S., and EDWARD HULL, B.A., F.G.S. Price 8d.
On the GEOLOGY of the SOUTH STAFFORDSHIRE COAL-FIELD. By J. B. JUKES, M.A., F.R.S. (3rd Edit.) 3s. 6d.
On the GEOLOGY of the WARWICKSHIRE COAL-FIELD. By H. H. HOWELL, F.G.S. 1s. 6d.
On the GEOLOGY of the COUNTRY around WOODSTOCK. Illustrating Sheet 45 S.W. By E. HULL, A.B. 1s.
On the GEOLOGY of the COUNTRY around PRESCOT, LANCASHIRE. By EDWARD HULL, A.B., F.G.S. (2nd Edition.) Illustrating Quarter Sheet, No. 80 N.W. Price 8d.
On the GEOLOGY of PART of LEICESTERSHIRE. By W. TALBOT AVELINE, F.G.S., and H. H. HOWELL, F.G.S. Illustrating Quarter Sheet, No. 63 S.E. Price 8d.
On the GEOLOGY of PART of NORTHAMPTONSHIRE. Illustrating Sheet 53 S.E. By W. T. AVELINE, F.G.S., and RICHARD TRENCH, B.A., F.G.S. Price 8d.
On the GEOLOGY of the ASHBY-DE-LA-ZOUCH COAL-FIELD. By EDWARD HULL, A.B., F.G.S. Illustrating Sheets 63 N.W. and 71 S.W. 1s. 6d.
On the GEOLOGY of PARTS of OXFORDSHIRE and BERKSHIRE. By E. HULL, A.B., and W. WHITAKER, B.A. Illustrating Sheet 13. Price 3s.
On the GEOLOGY of PARTS of NORTHAMPTONSHIRE and WARWICKSHIRE. By W. T. AVELINE, F.G.S. Illustrating Quarter Sheet 53 N.E. 8d.
On the GEOLOGY of the COUNTRY around WIGAN. By EDWARD HULL, A.B., F.G.S. Illustrating Sheet 89 S.W. on the One-inch Scale, and Sheets 84, 85, 92, 93, 100, 101 on the Six-inch Scale, Lancashire. (2nd Edition.) Price 1s.
On the GEOLOGY of TRINIDAD (West Indian Surveys). By G. P. WALL and J. G. SAWKINS, F.G.S., with Maps and Sections. 12s.
On the GEOLOGY of JAMAICA (West Indian Surveys). By J. G. SAWKINS, &c. With Maps and Sections. 8vo. 1871.
COUNTRY around ALTRINCHAM, CHESHIRE. By E. HULL, B.A. Illustrating 80 N.E. Price 8d.
GEOLOGY of PARTS of NOTTINGHAMSHIRE and DERBYSHIRE. By W. T. AVELINE, F.G.S. Illustrating 82 S.E. Price 8d.
COUNTRY around NOTTINGHAM. By W. T. AVELINE, F.G.S. Illustrating 71 N.E. Price 8d.
The GEOLOGY of PARTS of NOTTINGHAMSHIRE, YORKSHIRE, and DERBYSHIRE. Illustrating Sheet 82 N.E. By W. TALBOT AVELINE, F.G.S. Price 8d.
The GEOLOGY of SOUTH BERKSHIRE and NORTH HAMPSHIRE. Illustrating Sheet 12. By H. W. BRISTOW and W. WHITAKER. Price 3s.
The GEOLOGY of the ISLE OF WIGHT, from the WEALDEN FORMATION to the HEMPSTEAD BEDS inclusive, with Illustrations, and a List of the Fossils. Illustrating Sheet 10. By H. W. BRISTOW, F.R.S. Price 6s.
The GEOLOGY of EDINBURGH. Illustrating Sheet 32 (Scotland). Price 4s. By H. H. HOWELL and A. GEIKIE.
The GEOLOGY of the COUNTRY around BOLTON, LANCASHIRE. By E. HULL, B.A. Illustrating Sheet 89 S.E. Price 2s.
The GEOLOGY of BERWICK. Illustrating Sheet 34 Scotland. 1 inch. By A. GEIKIE. Price 2s.
The GEOLOGY of the COUNTRY around OLDHAM. By E. HULL, B.A. Illustrating 88 S.W. Price 2s.
The GEOLOGY of PARTS of MIDDLESEX, &c. Illustrating Sheet 7. By W. WHITAKER, B.A. Price 2s.
The GEOLOGY of the COUNTRY around BANBURY, WOODSTOCK, and BUCKINGHAM. Sheet 45. By A. H. GREEN, M.A. Price 2s.
The GEOLOGY of NORTH WALES. By PROFESSOR RAMSAY, LL.D. With an Appendix, by J. W. SALTER, A.L.S. Price 13s. boards. (Vol. III., Memoirs, &c.)
The GEOLOGY of the COUNTRY between FOLKESTONE and RYE. By J. DREW, F.G.S. (Sheet 4.)
The GEOLOGY of EAST LOTHIAN, &c. (Maps 30, 34, 41, Scot.) By H. H. HOWELL, F.G.S., A. GEIKIE, F.R.S., and J. YOUNG, M.D. With an Appendix on the Fossils by J. W. SALTER, A.L.S.
The GEOLOGY of part of the YORKSHIRE COAL-FIELD (88 S.E.) By A. H. GREEN M.A., J. R. DAKYNS, M.A., and J. C. WARD, F.G.S. Oct. 1869. 1s.
The GEOLOGY of the COUNTRY between LIVERPOOL and SOUTHPORT (90 S.E.) By C. E. DE RANCE, F.G.S. Oct. 1869. 3d.

THE COAL-FIELDS OF THE UNITED KINGDOM ARE ILLUSTRATED BY TH FOLLOWING PUBLISHED MAPS OF THE GEOLOGICAL SURVEY.

COAL-FIELDS OF UNITED KINGDOM.

(Illustrated by the following Maps.)

Anglesey, 78 (SW).
Bristol and Somerset, 19, 35.
Coalbrook Dale, 61 (NE & SE).
Clee Hill, 53 (NE, NW).
Denbighshire, 74 (NE & SE), 79 (SE).
Derby and Yorkshire, 71 (NW, NE, & SE), 82 (NW & SW), 81 (NE), 87 (NE, SE), 88 (SE).
Flintshire, 79 (NE & SE).
Forest of Dean, 43 (SE & SW).
Forest of Wyre, 61 (SE), 55 (NE).
*Lancashire, 80 (NW), 81 (NW), 89 (SE, NE, & SW), 88 (SW).
(For corresponding six-inch Maps, see detailed list.)
*Leicestershire, 71 (SW), 63 (NW).
Newcastle, 105 (NE & SE).
*North Staffordshire, 72 (NW), 72 (SW), 73 (NE), 80 (SE), 81 (SW).
*South Staffordshire, 54 (NW), 62 (SW).
Shrewsbury, 60 (NE), 61 (NW & SW).
*South Wales, 36, 37, 38, 40, 41, 42 (SE. SW).
*Warwickshire, 62 (NE & SE), 63 (NW & SW), 54 (NE), 53 (NW).
Yorkshire, 88, 87 (SW).

SCOTLAND.

*Edinburgh, 32, 33.
Fife and Kinross, 40, 41.
*Haddington, 32, 33.

IRELAND.

*Kanturk, 174, 175.
*Killenaule (Tipperary), 146.
*Castlecomer, 128, 137.
(For Sections illustrating these Maps, see detailed list.)
* With descriptive Memoir.

GEOLOGICAL MAPS OF ENGLAND AND SCOTLAND.

Scale, six inches to a mile.

The Coalfields of Lancashire, Northumberland, Durham, Yorkshire, Edinburghshire, Haddington, Fifeshire, and Ayrshire are being surveyed on a scale of six inches to a mile. Price 6s.

Lancashire.

48. Colne, Twiston Moor.
56. Haggate.
62. Balderstone, &c.
63. Accrington.
64. Burnley.
65. Stiperden Moor. 4s.
70. Blackburn, &c.
71. Haslingden.
72. Cliviger, Bacup, &c.
73. Todmorden. 4s.
78. Bolton-le-Moors.
79. Entwistle.
80. Tottington.
81. Wardle. 6s. - - Horiz. Sect. 66. Illustrates the sheet.
84. Ormskirk, St. John's, &c. the sheet.
85. Standish, &c.
86. Adlington, Horwick, &c. - " 68. "
87. Bolton-le-Moors - - " 67. "
88. Bury Heywood - - " 66. "
89. Rochdale, &c. - - " 66. "
92. Bickerstaffe, Skelmersdale.
93. Wigan, Up Holland, &c. - " 68. "
94. West Houghton, Hindley, Atherton - - - " 67. "
95. Radcliffe, Peel Swinton, &c. " 66-67. "
96. Middleton, Prestwich, &c. " 66. "
97. Oldham, &c. - - " 64. "
100. Knowsley, Rainford, &c. " 67-68. "
101. Billinge, Ashton, &c. - " 68. "
102. Leigh, Lowton - - " 67. "
103. Ashley, Eccles - - " 66. "
104. Manchester, Salford, &c. - " 64-65. "
105. Ashton-under-Lyne - " 64-65. "
106. Liverpool, &c. - - " 68. "
107. Prescott, Huyton, &c. - " 68. "
108. St. Helen's, Burton Wood " 67. "
109. Warwick, &c. 6s.
111. Cheedale, part of Stockport, &c.
112. Stockport, &c. 4s.
113. Part of Liverpool, &c. 4s.

Sheets 84, 85, 92, 93, 100, and 101 are included in the one-inch Map 89 SW. and are described in the "Memoir of the Geology of the Country around Wigan." Second edition. Price 1s.

Lancashire—*cont.*

Sheets 86, 87, 88 (in part), 94, 95, 96 (in part), 102, 103, 104 (part), are included in the one-inch Map 89 SE., and are described in the "Memoir on the Geology of the Country around Bolton-le-Moors."

Sheets 107, 108, are included in the one-inch Map 80 NW., and are described in the "Memoir on the Geology of the Country round Prescott."

Sheets 88, 89, 96, 97, 104, 105, 111, 112, on the six-inch scale, are included in 88 SW., and are described in a Memoir on the Geology of the Country around Oldham, including Manchester and its Suburbs.

Durham.

Scale, six inches to a mile.

Sheet.
1. Ryton. 4s.
2. Gateshead. 4s.
3. Jarrow. 4s.
4. S. Shields. 4s.
5. Greenside. 4s.
6. Winlaton.
7. Washington.
8. Sunderland.
9. —— 4s.
10. Edmond Byers. 4s.
11. Ebchester.
14. Chester-le-Street.
17. Waskerley.
20. Hetton-le-Hole.

Northumberland.

Scale, six inches to a mile.

56. Druridge Bay, &c.
68. Belingham.
69. Redesdale.
72. Bedlington.
73. Blyth. 4s.
77. Swinburn.
80. Cramlington.
81. Earsdon.
84. Newborough.
85. Chollerton.
86. Matfen.
87. Heddon-on-the-Wall.
88. Long Benton.
89. Tynemouth.
95. Corbridge.
96. Horsley. 4s.
97. Newcastle-on-Tyne. 4s.
98. Walker. 4s.
105.
109. Shofleyfield.

These Sheets are included in 105 NE., One inch.

Yorkshire.

201. Bingley.
246. Huddersfield.
260. Honley.
272. Holmfirth.
273. Penistone.
274. Barnsley.
281. Langsell.
287. Low Bradford.
293. Hallam Moors. 4s.

SCOTLAND.

Scale, six inches to a mile.

Edinburghshire.

2. Edinburgh, &c.
3. Portobello, Musselburgh, &c.
6. Gilmerton, Burdie House, &c.
7. Dalkeith, &c.
8. Preston Hall. 4s.
12. Penicuick, Coalfields of Lasswade, &c.
13. Temple, &c.
14. Pathead. 4s.
17. Brunston Colliery, &c.
18. Howgate.

These Sheets are included in Sheet 32, One-inch scale.

8. Preston Hall, &c.
14. Fala, &c.

Haddingtonshire.

Six inches to a mile.

8. Prestonpans, &c. Price 4s.
9. Trenent, Gladsmuir, &c. Price 6s.
13. Elphinstone, &c. Price 4s.
14. Ormiston, East Salton, &c.

These Sheets are included in Sheet 32, One-inch scale.

Horizontal Sections 82, 63, and Vertical Section 28 illustrate these Six-inch Maps.

Fifeshire.

Six inches to a mile.

24. Markinch, &c.
25. Scoonie, &c.
30. Beath, &c.
31. Auchterderran. 4s.
32. Dysart, &c.
33. Buckhaven.
35. Dunfermline.
36. Kinghorn.
37. Kinghorn. 4s.

Ayrshire.

Six inches to one mile.

19. Newmilns.
26. Glenbuck. 4s.
27. Monkton, &c.
28. Tarbolton, &c.
30. Aird's Moss.
31. Muirkirk. 4s.
33. Ayr, &c.
34. Coylton.
36. Grieve Hill.
40. Chiltree.
41. Dalleagler.
42. New Cumnock.
46. Dalmellington.
47. Benbeock.
50. Daily.
52. Glenmoat.

MINERAL STATISTICS.

Embracing the produce of Tin, Copper, Lead, Silver, Zinc, Iron, Coals, and other Minerals. By ROBERT HUNT, F.R.S., *Keeper of Mining Records*. From 1853 to 1857, inclusive, 1s. 6d. each. 1858, *Part I.*, 1s. 6d.; *Part II.*, 8s. 1859, 1s. 6d., 1860, 3s. 6d., 1861, 2s.; and Appendix, 1s. 1862, 2s. 6d. 1863, 2s. 6d. 1864, 2s. 1865, 2s. 6d. 1866, 1867, 1868, 1869, 2s. each.

THE IRON ORES OF GREAT BRITAIN.

Part I. The IRON ORES of the North and North Midland Counties of England (*Out of print*). Part II. The IRON ORES of South Staffordshire. Price 1s. Part III. The IRON ORES of South Wales. Price 1s. 3d. Part IV. The IRON ORES of the Shropshire Coal-field and of North Staffordshire. 1s. 3d.